IN THE CLAIMS

Please amend the claims as indicated in the following List of Claims. This list replaces all prior versions and listings of claims in the application.

1. (Original) A method for gas liquefaction comprising:

(a) cooling a feed gas in a first heat exchange zone by indirect heat exchange with one or more refrigerant streams provided in a first refrigeration system, and withdrawing a substantially liquefied stream from the first heat exchange zone;

(b) further cooling the substantially liquefied stream in a second heat exchange zone by indirect heat exchange with one or more work-expanded refrigerant streams provided by a second refrigeration system and withdrawing a further cooled, substantially liquefied stream from the second heat exchange zone; and

(c) work expanding two or more cooled compressed refrigerant streams in the second refrigeration system to provide at least one of the one or more work-expanded refrigerant streams in the second heat exchange zone, wherein the operation of the second refrigeration system includes the steps of

(1) compressing one or more refrigerant gases to provide a compressed refrigerant stream;

(2) cooling all or a portion of the compressed refrigerant stream in a third heat exchange zone to provide a cooled, compressed refrigerant stream; and

(3) work expanding the cooled, compressed refrigerant stream to provide one of the one or more work-expanded refrigerant streams;

wherein the flow rate of a work-expanded refrigerant stream in the second heat exchange zone is less than the total flow rate of one or more work-expanded refrigerant streams in the third heat exchange zone.

2. (Original) The method of Claim 1 wherein no cooling of the feed gas or the cooled feed stream occurs in the third heat exchange zone.

3. (Original) The method of Claim 1 wherein the flow rate of a compressed refrigerant stream being cooled in the third heat exchange zone is less than the total flow rate of one or more work-expanded refrigerant streams being warmed in the third heat exchange zone.

4. (Original) The method of Claim 1 wherein the first refrigeration system operates independently of the second refrigeration system.

5. (Original) The method of Claim 1 wherein the cooling of the feed gas in the first heat exchange zone is effected by a method comprising

(d) compressing and cooling a refrigerant gas containing one or more components to provide a cooled and at least partially condensed refrigerant;

(e) reducing the pressure of the cooled and at least partially condensed refrigerant to provide a vaporizing refrigerant and cooling the feed gas by indirect heat exchange with the vaporizing refrigerant in the first heat exchange zone to provide the substantially liquefied stream and the refrigerant gas of (d).

6. (Original) The method of Claim 5 wherein the feed gas is cooled prior to the first heat exchange zone by indirect heat exchange with a second vaporizing refrigerant.

7. (Original) The method of Claim 5 wherein at least a portion of the cooling of the refrigerant gas in (d) is provided by indirect heat exchange with a second vaporizing refrigerant.

8 (Original) The method of Claim 1 wherein a first portion of the compressed refrigerant gas is cooled in the third heat exchange zone and wherein a second

portion of the compressed refrigerant gas is cooled, work expanded, and warmed in the third heat exchange zone to provide refrigeration therein for cooling the first portion of the compressed refrigerant gas.

9. (Original) The method of Claim 1 wherein the compressed refrigerant gas is cooled in the third heat exchange zone and work expanded to provide a first work-expanded refrigerant, the first work-expanded refrigerant is divided into a first and a second cooled refrigerant, the first cooled refrigerant is warmed in the third heat exchange zone to provide refrigeration therein for cooling the compressed refrigerant gas, the second cooled refrigerant is further cooled and work expanded to provide a second work-expanded refrigerant, and the second work-expanded refrigerant is warmed in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone.

10. (Original) The method of Claim 1 wherein a first portion of the compressed refrigerant gas is cooled in the third heat exchange zone and work expanded to provide a first work-expanded refrigerant, a second portion of the compressed refrigerant gas is cooled by indirect heat exchange with a vaporizing refrigerant provided by a third refrigeration system and work expanded to provide a second work-expanded refrigerant, and the first and second work-expanded refrigerants are warmed in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone.

11. (Original) The method of Claim 1 wherein the compressed refrigerant gas is cooled in the third heat exchange zone to provide a cooled compressed refrigerant gas, and wherein a portion of the cooled compressed refrigerant gas is work expanded and warmed in the second heat exchange zone to provide cooling therein for the substantially liquefied stream from the first heat exchange zone.

12. (Original) The method of Claim 1 wherein the second refrigeration system is operated by a method comprising

(d) compressing a first refrigerant gas to provide the compressed refrigerant gas, and dividing the compressed refrigerant gas into first and second compressed refrigerants;

(e) cooling the first compressed refrigerant in the third heat exchange zone to provide a first cooled compressed refrigerant, work expanding the first cooled compressed refrigerant to provide a cold work-expanded refrigerant, warming the cold work-expanded refrigerant in the second heat exchange zone to provide refrigeration for cooling the cooled feed stream therein, and withdrawing an intermediate refrigerant therefrom;

(f) cooling the second compressed refrigerant by indirect heat exchange with a vaporizing refrigerant to provide a second cooled compressed refrigerant, work expanding the second cooled compressed refrigerant to provide a work-expanded second refrigerant, and combining the work expanded second refrigerant with the intermediate refrigerant to provide a combined intermediate refrigerant; and

(g) warming the combined intermediate refrigerant in the third heat exchange zone to provide refrigeration for cooling the first compressed refrigerant therein, and withdrawing therefrom a warm refrigerant to provide the first refrigerant gas.

13. (Original) The method of Claim 1 wherein the second refrigeration system is operated by a method comprising

(d) compressing a first refrigerant gas to provide the compressed refrigerant gas;

(e) cooling the compressed refrigerant gas in the third heat exchange zone to provide a cooled compressed refrigerant, and dividing the cooled compressed refrigerant into a first and a second cooled compressed refrigerant;

(f) further cooling the first cooled compressed refrigerant in the third heat exchange zone to provide a first further cooled refrigerant;

(g) work expanding the first further cooled refrigerant to provide a work-expanded first refrigerant and work expanding the second cooled compressed refrigerant to provide a work-expanded second refrigerant;

(h) warming the first work-expanded refrigerant and the second work-expanded refrigerant in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone and withdrawing a combined intermediate refrigerant from the second heat exchange zone; and

(i) warming the combined intermediate refrigerant in the third heat exchange zone to provide refrigeration for cooling the first compressed refrigerant therein and withdrawing therefrom a warmed refrigerant to provide the first refrigerant gas.

14. (Original) The method of Claim 1 wherein the second refrigeration system is operated by a method comprising

(d) compressing the first refrigerant gas and a second refrigerant gas in a multi-stage refrigerant compressor to provide a compressed refrigerant gas, and dividing the compressed refrigerant gas into a first and a second compressed refrigerant;

(e) cooling the first compressed refrigerant in the third heat exchange zone to provide a first cooled compressed refrigerant and work expanding the first cooled compressed refrigerant to provide a cold work-expanded refrigerant at a first pressure, and warming the cold work-expanded refrigerant in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone and withdrawing an intermediate refrigerant from the second heat exchange zone;

(f) cooling the second compressed refrigerant by indirect heat exchange with a vaporizing refrigerant to provide a second cooled compressed refrigerant, work expanding the second cooled compressed refrigerant to provide a work- expanded second refrigerant at a second pressure greater than the first pressure, warming the work-expanded second

refrigerant in the third heat exchange zone to provide refrigeration for cooling the first compressed refrigerant therein, and withdrawing therefrom a warmed refrigerant to provide the second refrigerant gas;

(g) warming the intermediate refrigerant in the third heat exchange zone to provide refrigeration for cooling the first compressed refrigerant therein, and withdrawing therefrom a warmed refrigerant to provide the first refrigerant gas; and

(h) introducing the first refrigerant gas into a first stage of the multi-stage refrigerant compressor and introducing the second refrigerant gas into an intermediate stage of the multi-stage refrigerant compressor.

15. (Original) The method of Claim 1 wherein the second refrigeration system is operated by a method comprising

(d) compressing a refrigerant gas to provide the compressed refrigerant gas, and dividing the compressed refrigerant gas into a first and a second compressed refrigerant;

(e) cooling the first compressed refrigerant in the third heat exchange zone to provide a first cooled compressed refrigerant and work expanding the first cooled compressed refrigerant to provide a first work-expanded refrigerant;

(f) cooling the first work-expanded refrigerant in the second heat exchange zone to provide a cooled first work-expanded refrigerant, work expanding the cooled first work-expanded refrigerant to provide a cold work-expanded refrigerant, warming the cold work-expanded refrigerant in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone, and withdrawing an intermediate refrigerant from the second heat exchange zone;

(g) cooling the second compressed refrigerant by indirect heat exchange with a vaporizing refrigerant to provide a second cooled compressed refrigerant, work expanding the second cooled compressed refrigerant to provide a work-expanded second refrigerant, and combining the

work-expanded second refrigerant with the intermediate refrigerant to provide a combined refrigerant; and

(h) warming the combined refrigerant in the third heat exchange zone to provide refrigeration for cooling the first compressed refrigerant therein and withdrawing therefrom the first refrigerant gas.

16. (Original) The method of Claim 1 wherein the second refrigeration system is operated by a method comprising

(d) compressing a first refrigerant gas and a second refrigerant gas in a multi-stage refrigerant compressor to provide the compressed refrigerant gas;

(e) cooling the compressed refrigerant gas in the third heat exchange zone to provide a first cooled compressed refrigerant, work expanding the first cooled compressed refrigerant to provide a first cold work-expanded refrigerant at a first pressure, and dividing the first cold work-expanded refrigerant into a first and a second cold refrigerant;

(f) warming the first cold refrigerant in the third heat exchange zone to provide refrigeration for cooling the first compressed refrigerant therein and withdrawing therefrom a warmed refrigerant to provide the second refrigerant gas;

(g) cooling the second cold refrigerant in the second heat exchange zone to provide a second cooled compressed refrigerant, work expanding the second cooled compressed refrigerant to provide a second work-expanded refrigerant at a second pressure that is less than the first pressure;

(h) warming the second work-expanded refrigerant in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone and to provide refrigeration for cooling the first compressed refrigerant in the third heat exchange zone, and withdrawing therefrom a warmed refrigerant to provide the first refrigerant gas; and

(i) introducing the first refrigerant gas into a first stage of the multi-stage refrigerant compressor and introducing the second refrigerant gas into an intermediate stage of the multi-stage refrigerant compressor.

17. (Original) The method of Claim 1 wherein the second refrigeration system is operated by a method comprising

(d) compressing a refrigerant gas to provide the compressed refrigerant gas, and dividing the compressed refrigerant gas into a first and a second compressed refrigerant;

(e) cooling the first compressed refrigerant in the third heat exchange zone to provide a first cooled compressed refrigerant and work expanding the first cooled compressed refrigerant to provide a cold work-expanded first refrigerant, warming the cold work-expanded first refrigerant in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone, and form a partially-warmed refrigerant in the second heat exchange zone;

(f) cooling the second compressed refrigerant by indirect heat exchange with a vaporizing refrigerant to provide an intermediate cooled refrigerant, further cooling the intermediate cooled refrigerant in the third heat exchange zone to provide a cooled second compressed refrigerant, and work expanding the second cooled compressed refrigerant to provide a work-expanded second refrigerant;

(g) combining the cold work-expanded second refrigerant and the partially-warmed refrigerant to provide a combined intermediate refrigerant, warming the combined intermediate refrigerant in the second heat exchange zone to provide additional refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone, and withdrawing a partially warmed refrigerant from the second heat exchange zone; and

(h) warming the partially warmed refrigerant in the third heat exchange zone to provide refrigeration for cooling the first compressed refrigerant and the second compressed refrigerant therein, and withdrawing therefrom a warmed refrigerant to provide the first refrigerant gas.

18. (Original) The method of Claim 17 which further comprises providing additional refrigeration to the third heat exchange zone by warming therein a portion of the one or more refrigerants provided in the first refrigeration system.

19. (Original) The method of Claim 17 which further comprises providing additional refrigeration to the first heat exchange zone by warming therein a portion of the intermediate cooled refrigerant provided in the second refrigeration system.

20. (Currently Amended) The method of Claim 1 wherein the second refrigeration system is operated by a method comprising

(d) compressing a first refrigerant gas and a second refrigerant gas in a multi-stage refrigerant compressor to provide the compressed refrigerant gas;

(e) cooling the compressed refrigerant gas in the third heat exchange zone to provide a cooled compressed refrigerant and dividing the cooled compressed refrigerant ~~refrigerant~~ into a first and a second cooled refrigerant;

(f) work expanding the first cooled refrigerant to provide a first work-expanded refrigerant at a first pressure, warming the first work-expanded refrigerant in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone and to provide refrigeration for cooling the first compressed refrigerant in the third heat exchange zone, and withdrawing therefrom a warmed refrigerant to provide the second refrigerant gas;

(g) cooling the second cooled refrigerant in the second heat exchange zone to provide a second cooled compressed refrigerant, work expanding the second cooled compressed refrigerant to provide a second work-expanded refrigerant at a second pressure that is less than the first pressure;

(h) warming the second work-expanded refrigerant to provide refrigeration for cooling the cooled feed stream in the second heat exchange

zone and to provide refrigeration for cooling the first compressed refrigerant in the third heat exchange zone, and withdrawing therefrom a warmed refrigerant to provide the first refrigerant gas; and

(i) introducing the first refrigerant gas into a first stage of the multi-stage refrigerant compressor and introducing the second refrigerant gas into an intermediate stage of the multi-stage refrigerant compressor.

21. (Original) The method of Claim 1 wherein the feed gas comprises natural gas.

22. (Original) The method of Claim 1 wherein the one or more refrigerants provided in the first refrigeration system are selected from the group consisting of nitrogen, hydrocarbons containing one or more carbon atoms, and halocarbons containing one or more carbon atoms.

23. (Original) The method of Claim 1 wherein the refrigerant gas in the second refrigeration system comprises one or more components selected from the group consisting of nitrogen, argon, methane, ethane, and propane.

24. (Original) A method for gas liquefaction comprising:

(a) cooling a feed gas in a first heat exchange zone by indirect heat exchange with one or more refrigerants provided in a first refrigeration system, and withdrawing a substantially liquefied stream from the first heat exchange zone; and

(b) further cooling the substantially liquefied stream in a second heat exchange zone by indirect heat exchange with a cold work-expanded refrigerant and withdrawing therefrom a further cooled, substantially liquefied stream;

wherein the cold work-expanded refrigerant is provided in a second refrigeration system comprising at least two refrigeration circuits by a method which includes

(1) compressing a refrigerant gas in a first refrigeration circuit to provide a compressed refrigerant gas;

(2) cooling the compressed refrigerant gas in a third heat exchange zone to provide a cooled, compressed refrigerant gas, wherein a portion of the cooling is provided therein by vaporizing a multicomponent refrigerant provided by a second refrigeration circuit;

(3) work expanding the cooled, compressed refrigerant gas to provide the cold work-expanded refrigerant; and

(4) warming the cold work-expanded refrigerant in the second heat exchange zone to provide refrigeration therein for cooling the substantially liquefied stream from the first heat exchange zone and to provide refrigeration for cooling the compressed refrigerant gas in the third heat exchange zone, and withdrawing therefrom a warmed refrigerant to provide the refrigerant gas.

25. (Original) The method of Claim 24 wherein no cooling of the feed gas or the cooled feed stream occurs in the third heat exchange zone.

26. (Original) In a method for gas liquefaction comprising

(a) cooling a feed gas in a first heat exchange zone by indirect heat exchange with one or more refrigerants provided in a first refrigeration system, thereby providing a cooled feed stream; and

(b) further cooling the cooled feed stream in a second heat exchange zone by indirect heat exchange with a work-expanded refrigerant provided by a second refrigeration system and withdrawing a further cooled stream from the second heat exchange zone, wherein the operation of the second refrigeration system includes the steps of

(1) compressing a refrigerant gas to provide a compressed refrigerant;

(2) cooling the compressed refrigerant to provide a cooled, compressed refrigerant;

(3) work expanding the cooled, compressed refrigerant to provide the work-expanded refrigerant;

wherein refrigeration for the cooling of the compressed refrigerant is provided in part by indirect heat exchange in a third heat exchange zone with work-expanded refrigerant from the second heat exchange zone and in part by balance refrigeration provided by the first refrigeration system;

the improvement comprising reducing or eliminating the need for the balance refrigeration by cooling and work expanding a portion of the compressed refrigerant to provide an additional work-expanded refrigerant, and utilizing the additional work-expanded refrigerant to provide additional refrigeration to the third heat exchange zone.

27. (Original) A system for gas liquefaction comprising:

(a) a first refrigeration system and first heat exchange means adapted for cooling a feed gas by indirect heat exchange with one or more refrigerants provided by the first refrigeration system in order to provide a substantially liquefied stream;

(b) a second refrigeration system and second heat exchange means adapted for further cooling of the substantially liquefied stream by indirect heat exchange with one or more cold work-expanded refrigerants provided by the second refrigeration system in order to provide a further cooled, substantially liquefied stream;

(c) gas compression means for compressing one or more refrigerant gas streams and third heat exchange means adapted for cooling one or more compressed refrigerant gas streams in the second refrigeration system;

(d) two or more expanders for work expanding cooled compressed refrigerant gas streams in the second refrigeration system to provide two or more cold work-expanded refrigerant streams; and

(e) piping means to transfer the two or more cold work-expanded refrigerant streams from the two or more expanders to the second heat exchange means or to the second and third heat exchange means.

28. (Original) The system of Claim 27 wherein the third heat exchange means is not adapted for cooling of the feed gas or the cooled feed stream.

29. (Original) The system of Claim 27 which further comprises a third refrigeration system adapted for cooling at least one of the one or more compressed refrigerant gas streams of the second refrigeration system.

30. (Original) The system of Claim 29 wherein the third refrigeration system is adapted for cooling the feed gas prior to the first heat exchange means.

31. (Original) A system for gas liquefaction comprising:

(a) a first refrigeration system and first heat exchange means adapted for cooling a feed gas by indirect heat exchange with one or more refrigerants provided by the first refrigeration system in order to provide a substantially liquefied stream;

(b) a second refrigeration system and second heat exchange means adapted for further cooling of the substantially liquefied stream by indirect heat exchange with one or more cold work-expanded refrigerants provided by the second refrigeration system in order to provide a further cooled, substantially liquefied stream;

(c) gas compression means for compressing a refrigerant gas stream and third heat exchange means adapted for cooling one or more compressed refrigerant streams;

(d) a third refrigeration system adapted to provide additional refrigeration to the third heat exchange means;

(e) an expander for work expanding a cooled compressed refrigerant stream in the second refrigeration system to provide a cold work-expanded refrigerant stream; and

(f) piping means to transfer the cold work-expanded refrigerant stream from the expander to the second heat exchange means.

32. (Original) The system of Claim 31 wherein the third heat exchange means is not adapted for cooling of the feed gas or the cooled feed stream.